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DEPARTMENT OF AGRICULTURE.

BULLETIN No. 74.

THE REPRESSION OF TUBERCULOSIS OF CATTLE BY SANITATION.

AN ACCOUNT OF A SPECIAL INVESTIGATION TO DETERMINE THE INFLUENCE OF GOOD AND BAD STABLING CONDITIONS ON THE SPREAD OF TUBERCULOSIS,

BY LEONARD PEARSON, STATE VETERINARIAN.

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PREFACE.

Harrisburg, Pa., January 10, 1901.

The State Veterinarian, Dr. Leonard Pearson, has conducted an investigation into the effect of direct sunlight, cleanliness and thorough ventilation in stables, upon the health of dairy cows. as compared with stables that are dark, poorly ventilated and illy kept. The value of proper surroundings and of stall partitions in preventing the spread of tuberculosis among dairy cattle, is demonstrated in the following Bulletin; and owners of herds, who are desirous of securing healthy conditions for their animals, will do well to carefully study the work of Dr. Pearson as set forth in this publication.

JOHN HAMILTON,
Secretary of Agriculture.

LETTER OF TRANSMITTAL.

Harrisburg, Pa., January 10, 1901.

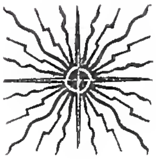
Hon. John Hamilton, Secretary of Agriculture, Harrisburg, Pa.:

Sir: I have the honor to transmit to you herewith a report on a special investigation conducted for the State Live Stock Sanitary Board, to determine the influence of good and bad stabling conditions on the spread of tuberculosis in two infected herds. This investigation furnishes strong reasons for the improvement of stabling conditions, and proves the value of good construction.

I have received valuable assistance during the progress of this investigation from Doctors M. P. Ravenel, W. G. Shaw, John J. Repp and E. Mayhew Michener, and from Mr. S. H. Gilliland; all of which I wish to gratefully acknowledge.

I beg to recommend that this report be published as a Bulletin of the Department of Agriculture under the authorization of the Act of May 11, 1899.

Yours respectfully,
LEONARD PEARSON,
State Veterinarian.



THE REPRESSION

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TUBERCULOSIS OF CATTLE BY SANITATION.

AN ACCOUNT OF A SPECIAL INVESTIGATION TO DETERMINE THE INFLUENCE OF GOOD AND BAD STABLING CONDITIONS ON THE SPREAD OF TUBERCULOSIS.

By Leonard Pearson, B. S., V. M. D.,
STATE VETERINARIAN.

SUMMARY.

The purpose of this investigation, which was made under the auspices of the State Live Stock Sanitary Board at the Veterinary Department of the University of Pennsylvania, was to measure the effect of good and bad stabling conditions on the progress of tuberculosis in two herds.

For the purpose of the investigation, two herds were established, of six cows each. Four cows in each herd were healthy and two cows in each herd were tubercular. One herd was kept in a roomy, light, clean, and well ventilated stable. The stalls and partitions between the mangers in this stable were so constructed that the cows were kept apart from each other.

The other stable was small, close, poorly ventilated, rather dark and not especially clean. The cows here were not separated by stall partitions, and they were all fed from the floor of the passageway in front of their stalls.

This experiment continued for 513 days or about 17 months, and at the close it was found that two of the originally healthy animals kept in the large, light stable, had contracted tuberculosis and the other two of the originally healthy cows continued sound. Of the four originally healthy cows in the small, dark stable, all had contracted tuberculosis. The progress of the disease in each infected animal in the dark stable was greater than in the infected animals in the light, airy stable.

It is concluded from this experiment that:

1. GOOD SANITARY CONDITIONS, CLEANLINESS AND THE COMPARATIVE ISOLATION AFFORDED BY SEPARATE MANGERS AND BY STALL PARTITIONS, HAVE A DECIDED EFFECT IN RESTRICTING THE SPREAD OF TUBERCULOSIS IN AN INFECTED HERD.
2. A POORLY VENTILATED AND POORLY LIGHTED STABLE, AND ONE IN WHICH THE CATTLE COME INTO DIRECT CONTACT, AS IS THE CASE WHEN THERE ARE NO PARTITIONS BETWEEN THE STALLS AND MANGERS, IS FAVORABLE TO THE SPREAD OF TUBERCULOSIS IN AN INFECTED HERD.
3. HOWEVER GOOD THE CONSTRUCTION AND SANITARY CONDITIONS OF THE STABLE AND HOWEVER GOOD THE CARE OF THE ANIMALS MAY BE, THE SPREAD OF TUBERCULOSIS CANNOT BE ALTOGETHER PREVENTED IF TUBERCULAR CATTLE AND HEALTHY CATTLE ARE KEPT IN THE SAME STABLE.

The experiment under consideration was commenced on the 6th of June, 1898. I shall first describe the building in which the experiment was carried on, then the cattle used, and, finally, the care received by these animals and the results of their exposure.

The two stables that are described here are under the same roof, but in entirely different parts of the building. They are separated from each other by a solid brick wall. The doors of the stables are on opposite sides of the building so that the effect is the same as though they had been placed about 100 feet apart, this being the distance that it is necessary to go, out-of-doors, to pass from one stable to the other.

The larger stable is 33 feet 10 inches long and 23 feet and 10 inches wide. The height at the rear wall is 10 feet and 6 inches and at the front wall 11 feet and 9 inches. The capacity of this room is 8,970 cubic feet. The windows are placed close together on the west, south and east sides. There are no windows or doors in the north wall, as this is the solid brick partition dividing the stable from the rest of the building. The total glass area of the windows amounts to 200 square feet. There are two doors, one on the east and the other on the south side. The doors are 4x8 feet in size and each is divided into an upper and lower half, the upper half of each being kept open during warm weather, thus adding 32 square feet through which light is admitted.

This stable is ventilated by four sheet iron tubes, 18 inches in diameter, one of which is placed in each corner, and by an opening on the east side to permit the entrance of air. Each ventilating shaft starts one foot from the floor, passes out through the roof and is surmounted by a metal ventilating cap. On the side of each shaft and close to the ceiling, there is an opening one foot wide and two feet long which may be closed by a slide. This is used in warm weather to remove warm air from the top of the stable, but in cold weather it is always closed. When this opening is closed, air enters the ventilators close to the floor.

The opening in the east door is a transverse slot 3 feet long and 10 inches high, 8 inches from the bottom of the door. This can be closed by a slide that falls from the top. On the inside of the door and in front of the slot there is a box that is closed on all sides, excepting the top. This box projects 4 inches from the face of the door. When the slide guarding this slot is pulled up, air enters from without and passes into the box, emerging from it at the top, passing in an upward direction. After many careful observations made for the purpose of determining the speed and direction of the air currents under different conditions, it was found that when all of the doors and windows were closed and the inlet for air on the east door was open and the air shafts were open only at the bottom, air passed out from the bottom of the stable through the ventilating shafts. When a door or window was open, air passed out at a higher level, through the door or window, and a downward current was established through the air shafts. By this system, the coldest and the foulest air in the stable is constantly removed from near the floor and the purer, warmer air in the upper part of the stable is conserved. The air of the stable is always very pure and scarcely any animal odor can be noticed and, although there is about 1,500 cubic feet of air space for each cow, the stable was warm and comfortable and did not freeze in the most severe weather, excepting once when the temperature out of doors was several degrees below zero.

The walls of this stable are made of brick and are coated with cement, thus making a very smooth surface. The ceiling is plastered on laths and painted. The floor is of cement. The six stalls are arranged in a row through the centre of the stable, the cows facing toward the east. The stalls are 4 feet wide and 5 feet long. The manure gutter is 16 inches wide and 6 inches deep. The mangers are cement basins, the walls of which rise 4 inches above the level of the floor, the bottom of each manger being level with the floor. These cement basins extend in a row in front of the stalls, each being as long as the stall is wide and 2 feet broad. The mangers are separated from each other by ridges of cement 4 inches high and by the wooden partitions described below.

The cows are fastened in swinging stanchions that are held in place by a few links of chain at the top and at the bottom. Between the cows' heads and separating the mangers, are wooden partitions made of well matched boards, planed and painted. These are 4½ feet high and 2½ feet broad. In front of each manger there is a partition 2 feet high. Stall partitions separate the cows. These are 4½ feet high at the front and 3½ feet high at the rear and extend back 3 feet and 2 inches. All of the wood work of the partitions and mangers is secured in place by hooks and dowels and can be readily removed, so that it can be cleansed very thoroughly. The passageways in front of the mangers and behind the manure gutter are 7½ feet wide. There is also a passageway 4 feet wide at each end of the row of stalls. No feed is stored in this room.

The other stable is 25 feet 10 inches long, 12 feet wide and 11 feet high. For the purpose of this experiment a temporary scaffold or ceiling was constructed of loose boards with spaces between, and upon this, straw was piled; this brought the ceiling down 3 feet or within 8 feet of the floor. With this arrangement the available air space was equivalent to about 3,000 cubic feet. There are two windows on the west side of this stable, but as these were boarded up during the experiment, they may be disregarded. The light that entered the stable, passed through 10 square feet of glass in a window beside the door at the north end and this window was closed excepting when men were working in the stable and during hot weather. That is, the window was closed about one-half of the period of the experiment. This stable was ventilated through two transoms, each 2½ feet wide by 1 foot high. These transoms were partly closed during the coldest weather. In the summer the upper part of the door was left open. The area of this half-door space is 16 square feet. The walls of the stable are of rough bricks. The floor is of clay and cinders 10 inches deep and well compacted. The cows were confined in a row of stanchions extending from the south end of the stable to within 4 feet of the north end. That is, a space of 21 feet 10 inches was allowed for the six cows. There is a feeding passageway in front of the rows of stanchions 3 feet 6 inches wide, which is planked, and the cows are fed from this common floor, excepting the cow in stall No. 6.

There was but one partition in the stable to separate a cow from her neighbor and to isolate her feeding place. A solid partition 5½ feet high of matched boards was constructed to shut off stall No. 6—the last one of the row. This was done to see whether such isolation would amount to anything in the way of protecting the cow from infection under the conditions that prevailed in the dark stable. This partition extended forward to the wall in front of the cows and a door in it had to be opened to feed the cow in stall No. 6.

The eight healthy cows used in this experiment were purchased from a drover who had just brought them from Ohio. The individual animals are described at the end of this report. Each cow was tested by Dr. Michener on the 2d and 3d of May, 1898, and again by Dr. Shaw on the 18th and 19th of May, 1898. The dose of tuberculin used for the second test was twice the usual quantity. None of the cows reacted at either of these preliminary tests. During the progress of the experiment, they were tested on the 26th and 27th of September, 1898, and following this no test was made until the 17th and 18th of October, 1899.

The eight healthy cows were divided into two lots as nearly equal in all respects, as possible, and one lot of four cows was placed in the light stable while the other lot was placed in the dark one. The healthy cows were so distributed that they occupied stalls at the ends and at the middle of the row in each stable. This left two stalls in each stable, next to the end of each row, for tubercular cows.

This arrangement is indicated as follows (the letter T stands for tubercular cow and H for healthy cow):

Order of cows, ...	H	T	H	H	T	H
Number of stalls, ...	1	2	3	4	5	6

It will be observed that each healthy cow stood next to a cow with tuberculosis.

The tubercular cattle used in this experiment were animals that had been condemned and were kept for a time for this purpose before they died or were destroyed. Eight tubercular cows were used at different times during this experiment, but not more than four, two in each stable, were used at any one time. The stage of infection in these animals varied in intensity from mild incipient lesions to advanced generalized disease.

One tubercular cow, No. 5986, was used throughout the entire experiment. This cow was thought, when she was first obtained for this work, to be afflicted with tuberculosis in a very advanced stage. Her weight on June 6, 1898, was 775 pounds. She was very thin and coughed a great deal. During the progress of the experiment she gained 130 pounds, and weighed, just before she was killed on December 9, 1899, 909 pounds. Sputum was collected from this cow and examined by Dr. Ravenel, who found tubercle bacilli in vast numbers in every sample examined. About one year before the death of the cow, that is, December, 1898, the udder became noduled. The hard nodular areas within the udder increased in size until, finally, one-half of the udder was hard and swollen. This cow yielded milk of terrific virulence containing vast numbers of tubercle bacilli. Upon post mortem examination, it was found that two-thirds of the lung tissue was the seat of lesions of tuberculosis. Cheesy areas were also present in the post pharyngeal lymphatic glands which were much enlarged. Some of the mesenteric lymphatic glands were from 5 to 8 inches in length and 3 inches thick, being full of cheesy debris. The udder and the supra-mammary lymphatic glands were extensively tubercular.

It was rather surprising that this cow should have gained 130 pounds during the 523 days that she was under observation; but it is even more surprising to know that all the other tubercular cattle in the experiment gained in weight while the experiment was under way. For example, cow No. 7921, Jersey, 3 years old, was brought into the experiment as one of the infected cows on June 23, 1898. At that time she was thin, the coat was harsh and dry, the skin tight and she coughed considerably. Her weight was 705 pounds. She was kept in the experiment 139 days and gained 140 pounds, practically 1 pound a day. This cow was killed on the 1st of December, 1898, and it was then found that both lungs contained a great many tubercular abscesses, the walls of which were thick and incrusted with lime salts. The surface of each lung was pretty thickly covered with tubercular growths, many of which seemed to be of quite recent formation. The anterior and posterior mediastinal glands contained old tubercular abscesses with thick walls. Many tubercular growths were also found on the peritoneum, and these lesions seemed to be of recent development.

Cow No. 7605, was obtained at the beginning of the experiment. She was a red and white cow, 9 years old. She weighed at the beginning 731 pounds, and on November 3, 863 pounds; that is, she gained 132 pounds in 122 days. This cow was not extensively tubercular, lesions being confined to small areas in the lungs.

The other tubercular cattle used in the experiment gained somewhat in weight. All of these cows when brought into the experiment, were regarded as advanced cases. They had reacted to the tuberculin test, they showed physical signs of tuberculosis, and they were all out of condition and losing weight. After they were brought into the experiment, if they were milking, they were dried off as rapidly as possible and were well fed. This appears to be the reason for their gain in weight during all but the very last stages of the disease.

In order that the exposure of the cattle in the light and in the dark stable might be as nearly equal as possible in respect to the number of tubercular bacilli discharged into the stable by tubercular cattle, and to prevent any irregularity that might arise from the presence of more advanced cases in one stable than in the other, the tubercular cows were changed every ten days from one stable to the other. That is, every ten days the two tubercular cows in the light stable were transferred to the dark stable, and the two tubercular cows in the dark stable were transferred to the light one. As the dark stable was dusty and the cattle in it were not groomed, the tubercular cows from that stable were sponged off with a solution of creolin before they were placed in the light stable.

The food of the two lots of cattle was the same. They were given rations composed of corn, bran, oats, linseed cake and mixed hay. The nutritive ratio was approximately 1 to 6.5. Each cow was allowed about 8 pounds of grain a day and the cattle in the two stables were fed precisely alike.

The cows were confined all of the time, excepting when they were led out of the stable once a week to be weighed. The confinement did not appear to harm any of the cattle by causing injury to their legs or feet, excepting in the case of cow No. 6520 in the dark stable which was troubled some with hoof ail and required treatment, now and then, to keep this disease in check.

Both lots of cattle were cared for by the same men, but special overshoes and overgarments were worn in the dark stable and these were kept outside of the door of that stable. In attending to the stable work, the men first fed and milked the cows in the light stable and cleaned out the manure and afterwards attended to the cattle in the dark stable.

The light stable was kept scrupulously clean at all times. Not only was the manure cleaned out three times a day, but the stall partitions and the mangers were washed off with a disinfectant every day. The whole stable, including the floor, walls, ceiling, windows, mangers, and all of the wood work were scrubbed with water and soap once a week. The walls were kept white with magnite ("water paint"). The ceiling, window frames, doors, partitions between the stalls and mangers and the posts were kept freshly painted; a new coat of paint being applied whenever there was any cracking or peeling. The floor of the light stable, before it was swept, was sprinkled with saw dust wet with an antiseptic solution. In sweeping, a floor brush was used in place of the ordinary broom for the reason that it could be used without making so much dust.

For bedding, planer shavings were used. These are very clean and less dusty than any other kind of bedding. It was found that some of the shavings were knocked into the mangers by the cows and it was necessary to clean the mangers before feeding. For this purpose, brushes of straw were used, one for each cow. These brushes were kept in front of the stalls to which they belonged and each brush was used for cleaning the manger of but one certain cow.

The cows were watered from buckets. The buckets were marked with numbers corresponding to the numbers of the stalls. In this way each bucket was reserved for the use of an individual cow and was not used for any other. The cows in this stable were groomed carefully. Two sets of curry combs, brushes, etc., were employed; one set for the two tubercular cows and the other set for the four originally healthy cows. These sets of utensils were kept in separate boxes outside of the stable.

In the dark stable, the cows were cared for in a less careful way, excepting in the matter of feeding and watering. The food was of the same quantity and quality as that used in the light stable and for watering, separate buckets were used, as in the other stable. The manure was removed twice daily. The cows were bedded with straw, and they were groomed only at long intervals. The scaffolding, in the top of the stable loaded with straw, made an uneven surface upon which spiders spun their webs. In the course of time long festoons of dusty cobwebs collected and were permitted to remain.

It will be seen that in the light stable everything was done to avoid a dusty atmosphere and to make it impossible for tubercle bacilli to accumulate. In the dark stable a dusty atmosphere was favored and the accumulation of organisms was permitted.

During the summer, the stables were shielded by awnings, which were lowered only while the sun was shining upon the part of the stable that could be protected by them. The awnings were not used excepting on hot days. On the whole, the stables were very comfortable both in summer and winter.

The cows in the dark stable gained more in weight than those in the light stable. The total gain for the four originally healthy cows in the light stable, during the entire period of the experiment, was 566 pounds, and of the four originally healthy cows in the dark stable it was 612 pounds. The cows in the light stable had a decidedly vigorous appearance, while those in the dark stable were, comparatively, sluggish and dull.

As to the results of the exposure carried out under these conditions, it will be observed that when the first tuberculin test was made. 82 days after the beginning of the experiment, one of the four originally healthy cows in the light stable and two of the originally healthy cows in the dark stable reacted, so that up to that point 25 per cent. of the exposed animals in the light stable had contracted tuberculosis and 50 per cent. of the animals in the dark stable had contracted tuberculosis. When the tuberculin test was applied October 17 and 18, 1899, fifteen months after the beginning of the experiment, it was found that two of the four originally healthy cows in the light stable reacted and all of the originally healthy cows in the dark stable reacted, so that at this time 50 per cent. of the exposed animals in the light stable were infected and 100 per cent. of the exposed animals in the dark stable were infected.

By reference to the description of the individuals used in the experiment, it will be observed that the lesions found in the cows infected in the dark stable were more wide spread and more extensive than in the cows infected in the light stable.

There were several ways by which tubercle bacilli may have passed from the tubercular to the healthy cows in the dark stable. There were no partitions between these cows' heads nor between their stalls. They could breathe upon such other, cough upon and toward each other and lick up food from surfaces that had been fed from and coughed upon by tubercular cows. From the distribution of the lesions in the cows that became affected, it seems probable that some of them had acquired infection by swallowing tubercle bacilli, and others by inhaling them. This, however, is a matter upon which it is difficult to form an opinion, because the age of a tubercular lesion can not be determined accurately. In this stable, tubercle bacilli floated in the air as dust. The rough surfaces, the straw ceiling, the cobwebs, all served as resting places for dust, whence it could be dislodged into the atmosphere by a gust of air or by the movements of the animals and thus once more come within the reach of the cattle. Fragments of food, etc., were allowed to collect on the feeding floor and on the wall in front of it. As these masses, together with the material expectorated by tubercular cows in coughing, were dried and pulverized, they entered the air as dust and could then be inhaled or swallowed. That tubercle bacilli were carried in the air in the dark stable was shown by the infection of the cow in stall No. 6, which was cut off from direct contact with the tubercular cow in the next stall. The same thing is shown more clearly by the infection of a guinea pig kept for four months in a cage suspended from the ceiling in the middle of the stable. The guinea pig died of tuberculosis. The lesions were distributed throughout both body cavities.

In the light stable, the cows were separated by partitions between their stalls and their mangers. They could not come into direct contact with each other. The food of one cow could not be contaminated by another cow by coughing upon it. No accumulation of dirt of any sort was permitted. It seems, therefore, that in this case infection must have been carried by tubercle bacilli suspended in drops of moisture sprayed from the respiratory passage by violent expiration, as in coughing. Guinea pigs kept in a cage suspended from the ceiling of this stable remained sound.

To test the virulence of the sputum of infected cows, Dr. Ravenel made some examinations of samples collected in nose-bags suspended from the muzzles of the tubercular cattle. He reports: "Of thirty-four examinations carried out on five different animals, tubercle bacilli were detected by microscopic examination twenty times. The number of bacilli found varied greatly, but one of the five animals constantly coughed up tenacious mucous in which the numbers approached those seen in human sputum in very advanced cases." By this method he was able to detect tubercle bacilli in the expectorations or saliva of every tubercular cow on which it was tried.

Since this stable was always so free from dust and as nearly perfectly clean as it could possibly be kept, no other explanation of the transference of infectious material has occurred to me. If the tubercle bacilli were distributed in this way, it would appear that all of the cows in the stable were exposed to them and approximately to the same extent because, necessarily, as many tubercle bacilli were discharged in the vicinity of one cow as in the vicinity of another. But when they are projected into the atmosphere of a large, well ventilated stable (that is, one in which there is frequent renewal of air), the number of tubercle bacilli that can come within reach of an individual cow must be comparatively small. It is, probable therefore, that of the four originally healthy cows in the light stable, each was exposed to approximately the same number of tubercle bacilli, but in two of these cows this number of germs was not sufficient to produce infection. Two cows were able to resist and to destroy the limited numbers of tubercle bacilli that entered their bodies. It may be that they would have become infected if the experiment had continued longer. Whether they would have yielded to the attacks of the same number of organisms had they been confined in a badly ventilated. dark stable, is an interesting question. This question cannot be answered by the result of this experiment, because the cows that were confined in the dark, badly ventilated stable were also exposed to more tubercle bacilli, since they were in more direct contact with the diseased cattle that were excreting them.

There can be no doubt, however, that the cows in the light stable were, at the close of the experiment, possessed of more vigor and strength than those in the dark one. This was shown clearly by their bright appearance and the activity and strength of their movements when they were led out of the stable to be weighed.

It is to be observed that the cows in the dark stable put on more weight with the same feed than did those in the light one. The gain made by the four originally healthy cows in the light stable during the experiment was 566 pounds, and the gain made by the four originally healthy cows in the dark stable was 612 pounds. It is common to regard an animal increasing in weight as an animal that is healthy, but that this is not always the case is shown clearly by this experiment, wherein the animals that were most extensively diseased increased in weight most rapidly. This fact comes out very strikingly when we compute the gains made during the different periods of the experiment. During the last period, that is, from June, 1899, to November, 1899, we find that the four originally healthy cows in the light stable gained 212 pounds and the four originally healthy ones in the dark stable gained 321 pounds. That is, the total gains made by four cows all of which were markedly tubercular was 51 per cent. more than the gains made by four cows fed in the same way and only two of which were tubercular. During the last four months of the experiment, the two cows that had contracted tuberculosis in the light stable gained 127 pounds and the two cows remaining healthy in the same stable, receiving the same food, gained 85 pounds.

It seems probable that an animal afflicted with tuberculosis is, in some stages of the disease, more inclined than a healthy animal to lay on fat. This tendency is sometimes marked until a rather advanced stage of the disease.

The question may be asked, could not the disease become latent in the two cows infected in the light stable, in view of their good hygienic surroundings? In answer to this question, it may be said that these conditions were not sufficient to prevent these animals from becoming infected, nor to prevent the disease from reaching a certain and considerable development. There is, therefore, no reason to suppose that the same conditions continued could check the disease after it was thus well established.

As to what would have occurred if the animals had been given exercise out of doors, we cannot forsee. Of course, it is well known that fresh air is one of the best remedies for consumption. However, the cows in the light stable had plenty of fresh air. They had practically as much oxygen as they could have gotten out of doors and were protected from the weather. The only thing that they were deprived of was exercise. Exercise was not allowed because it was the purpose of the experiment to compare stable conditions, and it was desired to know just what results would follow the stabling together of tubercular and healthy cattle under certain conditions, apart from other influences.

Cow No. 7911. Brindle and white cow, dehorned, age 8 years. Brought from Ohio to Montgomery county, Pa., and purchased there May 5, 1898. She had a heifer calf on June 9, 1898. Her weights were as follows:*

June, 1898,	865 pounds.
January, 1899,	833 pounds.
June, 1899,	966 pounds.
November, 1899,	1,020 pounds.

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* All the cows in this experiment were weighed every week, on Monday. The weights here given are the averages of the weights for the months specified.

This cow did not react upon either of the preliminary tests. The other tests were as follows:

September 26, 1898.—8 A. M., 101.6; 1 P. M., 101.2; 10 P. M., 101.6.

0.8 c. c. of tuberculin 9-26 at 10 P. M.

September 27, 1898.—4 A. M., 103; 6 A. M., 104; 8 A. M., 104.1; 10 A. M., 104.4; 12 N., 106.8; 2 P. M., 105.8; 4 P. M., 105.8.

October 17, 1899.—12 N., 101.4; 6 P. M., 102; 9 P. M.,101.4.

0.8 c. c. of tuberculin 10-17 at 10 P. M.

October 18, 1899.—5 A. M., 101.8; 7 A. M., 102.8; 9 A. M., 104; 11 A. M., 105.6; 1 P. M., 105.6; 3 P. M., 106; 5 P. M., 105.4.

This cow occupied stall No. 1 (the north stall) in the light stable. She remained in very good condition throughout the experiment, and did not cough or show symptoms of any disease. She was killed December 9, 1899. The condition of nutrition was very good. There was much subcutaneous and abdominal fat. In the left lung, in the upper part of the middle lobe, there was a cheesy tubercular area one and one-half inches in diameter, and a short distance below it another similar area one inch in diameter. The mediastinal glands, both anterior and posterior, were enlarged to three times the normal size and contained cheesy foci from one and one-fourth to one and one-half inches in diameter. All other organs were normal.

Cow No. 6533. Red and white cow, dehorned, age 9 years. This cow was brought from Ohio to Montgomery county, Pa., and purchased there May 5, 1898. She had a bull calf June 9, 1898. Her weights were as follows:

June, 1898,	1,015 pounds.
January, 1899,	1,092 pounds.
June, 1899,	1,196 pounds.
November, 1899,	1,225 pounds.

This cow did not react upon either of the preliminary tests. The other tests resulted as follows:

September 26, 1898.—8 A. M., 101.2; 1 P. M., 101.2; 10 P. M., 101.5.

0.8 c. c. of tuberculin 9-26 at 10 P. M.

September 27, 1898.—4 A. M., 101.4; 6 A. M., 101.2; 8 A. M., 101; 10 A. M., 101.3; 12 N., 102; 2 P. M., 101.8; 4 P. M., 102.

October 17, 1899.—12 N. 101.5; 6 P. M., 102.1; 9 P. M., 102.2.

0.8 c. c. of tuberculin 10-17 at 10 P. M.

October 18, 1899.—5 P. M., 101.5; 7 P. M., 101; 9 P. M., 101.5; 11 P. M., 101.4;1 P. M., 101.2; 3 P. M., 102.4; 5 P. M., 102.8.

This cow occupied stall No. 3 in the light stable. She remained in very good condition throughout the experiment and did not cough nor show symptoms of disease. She was killed February 10, 1900, and no lesions of tuberculosis were found.

Cow No. 7912. Fawn colored cow, dehorned, age 3 years. Brought from Ohio to Montgomery county, Pa., and purchased there May 5, 1898. She had a heifer calf on June 21, 1898. Her weights were as follows:

June, 1898,	782 pounds.
January 1899,	774 pounds.
June, 1899,	791 pounds.
November, 1899,	864 pounds.

This cow did not react upon either of the preliminary tests. The other tests resulted as follows:

September 26, 1898.—8 A. M., 101.5; 1 P. M., 102; 10 P. M., 102.

0.8 c. c. of tuberculin 9-26 at 10 P. M.

September 27, 1898.—4 A. M., 102; 6 A. M., 102; 8 A. M., 101.5; 10 A. M., 102.2; 12 N., 102; 2 P. M., 101.8; 4 P. M., 102.

October 17, 1899.—12 N., 101.2; 6 P. M., 102.6; 9 P. M., 101.7.

0.8 c. c. of tuberculin 10-17 at 10 P. M.

October 18, 1899.—5 A. M., 104.4; 7 A. M., 105.2; 9 A. M., 106.4; 11 A. M., 106.4; 1 P. M., 106.2; 3 P. M., 106.2; 5 P. M., 105.1.

This cow occupied stall No. 4 in the light stable. She was in good condition throughout the experiment, excepting for four months from September 26, 1898. On that day she fell on the cement floor while she was being taken out to be weighed. The left hip joint was bruised, making the cow lame and uncomfortable for about three months. The animal was not restored to her original condition for another month.

This cow was killed December 4, 1899. The condition of nutrition was good. There was considerable fat around the kidneys and intestines. On the right costal pleura there were cauliflower-like growths along the lower portion. The largest of these was three inches in diameter and one-half inch thick. The surface covered by them was about 12 inches long and from 6 to 12 inches broad. At the lower part of the right lung there was a tubercular mass 3 inches in diameter of cauliflower-like appearance. Upon section it was found that this growth contained cheesy pus. There was also a small mass of the same character one inch in diameter at the anterior extremity of the anterior lobe of the right lung. The pleurae of the left side and of the left lung were normal. The mediastinal and bronchial glands were cheesy. All other organs were normal.

Cow No. 7648. Red and white grade Guernsey cow, age 9 years.

This cow was brought from Ohio to Montgomery county, Pa., and purchased there June 3, 1898. She had a heifer calf on June 3, 1898. Her weights were as follows:

June, 1898.	716 pounds.
January, 1899,	797 pounds.
June, 1899,	779 pounds.
November, 1899,	835 pounds.

This cow did not react to either of the preliminary tests. The other tests resulted as follows:

September 26, 1898.—8 A. M., 101.8; 1 P. M., 101.2; 10 P. M., 101.6.

0.8 c. c. of tuberculin 9-26 at 10 P. M.

September 27, 1898.—4 A. M., 101.8; 6 A. M., 101.8; 8 A. M., 101.8; 10 A. M., 101.6; 12 N., 101.7; 2 P. M., 101.6; 4 P. M., 101.5.

October 17, 1899.—12 N. 101.2; 6 P. M., 102.3; 9 P. M., 101.4.

0.8 c. c. of tuberculin 10-17 at 10 P. M.

October 18, 1899.—5 A. M., 101.8; 7 A. M., 101.1; 9 A. M., 101.2; 11 A. M., 101.8; 1 P. M., 102.3; 3 P. M., 102.2; 5 P. M., 102.2.

This cow occupied stall No. 6 in the light stable. She did not cough nor show any indication of disease throughout the experiment. She was killed February 10, 1900, and no lesions of tuberculosis were found.

Cow No. 7920. Black cow, age 8 years. This cow was brought from Ohio to Montgomery county, Pa., and purchased there May 15, 1898. She had a heifer calf April 20, 1898. Her weights were as follows:

June, 1898,	897 pounds.
January, 1899,	976 pounds.
June, 1899.	937 pounds.
November, 1899,	957 pounds.

This cow did not react to either of the preliminary tests. The other tests resulted as follows:

September 26, 1898.—8 A. M., 100; 1 P. M., 101; 10 P. M., 101.2.

0.8 c. c. of tuberculin 9-26 at 10 P. M.

September 27, 1898.—4 A. M., 101.7; 6 A. M., 100.6; 8 A. M., 101; 10 A. M., 102.7; 12 N., 105; 2 P. M., 105; 4 P. M., 104.3.

October 17, 1899.—12 N. 101.5; 6 P. M., 102.7; 9 P. M., 103.2.

0.8 c. c. of tuberculin 10-17 at 10 P. M.

October 18, 1899.—5 A. M., 102.6; 7 A. M., 102.7; 9 A. M., 103.2; 11 A. M., 104.3; 1 P. M., 103.7; 3 P. M., 102.6; 5 P. M., 102.

This cow occupied stall No. 1 in the dark stable. She commenced to go back in condition in the early part of the summer of 1899. This loss of condition was not shown so much by loss of weight as it was by the rough, harsh coat, tight skin and by a certain loss of vigor. In the later part of the summer, beginning about August, the cow coughed badly and this symptom became more prominent until she was killed on November 10, 1899. The following is a report of the post-mortem examination:

The costal pleurae were studded with many small nodules about one-fourth of an inch in diameter. Some of these contained cheesy pus, others were of bright red color. The left lung had a few nodules of similar character on its surface but none in its substance. The right lung had, along the lower border, a number of mushroom-shaped growths one-half to one inch in diameter. These were found on the anterior, middle and posterior lobes and extended upward for from two and one-half to three inches from the lower border. A cheesy mass one-half inch in diameter was found in the substance of the middle lobe of the right lung, and close to the lower border a similar lesion was found, also one in the lower part of the anterior lobe. The surface of the posterior lobe was almost completely covered by mushroom-like growths. The supra-sternal gland had a number of calcified nodules. The mediastinal glands were considerably enlarged and contained many nodules, some of which were cheesy and others calcified. The anterior surface of the diaphragm was covered with tubercular growths from one to two inches thick and containing many large and small cheesy foci. The posterior surface of the diaphragm was thickly studded with gray tubercular nodules up to the size of a split pea. The omentum and the visceral layers of the peritoneum were thickly studded with nodules one-sixteenth of an inch in diameter and with shreds of fibrin one-half to one inch long. The anterior surface of the liver showed a great many mushroom-like growths that were attached only to the capsule and easily removable. These were from one-thirty-second to three-fourths of an inch in diameter. Upon section the liver was normal. A few of the mesenteric glands were large and cheesy. The lymphatic glands of the udder were enlarged and congested. The left post pharyngeal lymphatic gland was enlarged and almost double its normal size and contained two yellow cheesy foci one-half inch in diameter, each of which was surrounded by strong, fibrous walls.

Cow No. 6520. Roan cow, dehorned, age 7 years. This cow was brought from Ohio to Montgomery county, Pa., and purchased there May 5, 1898. She had a calf on April 20, 1898. Her weights were as follows:

June, 1898,	951 pounds.
January, 1899,	1,004 pounds.
June, 1899,	995 pounds.
November, 1899,	1,104 pounds.

This cow did not respond to either of the preliminary tests. The other tests resulted as follows:

September 26, 1898.—8 A. M., 101.6; 1 P. M., 102; 10 P. M., 102.4. 0.8 c. c. of tuberculin 9-26 at 10 P. M.

September 27, 1898.—4 A. M., 102.3; 6 A. M., 101.6; 8 A. M., 100.6; 10 A. M., 100.3; 12 N., 101.3; 2 P. M., 101.5; 4 P. M., 101.6.

October 17, 1899.—12 N. 101.5; 6 P. M., 102.2; 9 P. M., 101.9. 0.8 c. c. of tuberculin 10-17 at 10 P. M.

October 18, 1899.—5 A. M., 102.5; 7 A. M., 103; 9 A. M., 104; 11 A. M., 105.3; 1 P. M., 105.2; 3 P. M., 105.2; 5 P. M., 103.8.

This cow occupied stall No. 3 in the dark stable. She remained in good condition throughout the experiment and was killed November 29, 1899. The animal was well nourished and had a great deal of fat around the kidneys and intestines. On the upper part of the left lung there were a number of cauliflower-like growths three-fourths of an inch in diameter. A number of similar and smaller growths occurred on the outer surface of the posterior lobes and several on the median surface. One of the latter was three inches in diameter. All of these contained cheesy pus. In the substance of each lung there were a number of tubercular nodules from one to two inches in diameter. The left bronchial gland was the size of of an orange and cheesy. Two mesenteric lymphatic glands were enlarged and cheesy.

Cow No. 7915. Roan cow, age 7 years. This cow was brought from Ohio to Montgomery county, Pa., and purchased there May 15, 1898. She had a calf June 20, 1898. Her weights were as follows:

June, 1898, ...	900 pounds.
January, 1899, ...	924 pounds.
June, 1899, ...	1,019 pounds.
November, 1899, ...	1,115 pounds.

This cow did not respond to either of the preliminary tests. The other tests resulted as follows:

September 26, 1898.—8 A. M., 102; 1 P. M., 102; 10 P. M., 101.6. 0.8 c. c. of tuberculin 9-26 at 10 P. M.

September 27, 1898.—4 A. M., 104.7; 6 A. M., 105; 8 A. M., 104.8; 10 A. M., 105; 12 N., 105; 2 P. M., 104.2; 4 P. M., 103.

October 17, 1899.—12 N., 101.2; 6 P. M., 101.8; 9 P. M., 101.6. 0.8 c. c. of tuberculin 10-17 at 10 P. M.

October 18, 1899.—5 A. M., 104.4; 7 A. M., 105.2; 9 A. M., 106.5; 11 A. M., 106.2; 1 P. M., 105.4; 3 P. M., 105; 5 P. M., 104.9.

This cow occupied stall No. 4 in the dark stable. She remained in fair condition throughout the experiment but coughed some for the last three months; still, not more than many non-tubercular cows cough, and scarcely enough to attract attention. She was killed

October 29, 1899. General condition was good. There was much subcutaneous and abdominal fat. In the middle lobe of the left lung there were six tubercular areas from one-half to two inches in diameter, broken down and cheesy. There were many smaller tubercular nodules the size of a pea. The right lung had many small cheesy foci from one-fourth to one inch in diameter. The bronchial glands were enlarged and cheesy. One post pharyngeal gland was tubercular. The udder appeared to be normal, as were its lymphatic glands. This cow gave infectious milk during a part of the experiment.

Cow No. 7914. White cow, age 4 years. This cow was brought from Ohio to Montgomery county, Pa.. and purchased there May 5, 1898. She had a bull calf on May 21, 1898. The weights of this cow were as follows:

June, 1898, ...	752 pounds.
January, 1899, ...	825 pounds.
June, 1899, ...	850 pounds.
November, 1899, ...	946 pounds.

This cow did not respond to either of the preliminary tests. The other tests resulted as follows:

September 26, 1898.—8 A. M., 101; 1 P. M., 102; 10 P. M., 101.5.

0.8 c. c. of tuberculin 9-26 at 10 P. M.

September 27, 1898.—4 A. M., 101.9; 6 A. M., 101.4; 8 A. M., 101; 10 A. M., 101.4; 12 N., 102.2; 2 P. M., 102.5; 4 P. M., 101.9.

October 17, 1899.—12 N. 101.7; 6 P. M., 101.1; 9 P. M., 102.2.

0.8 c. c. of tuberculin 10-17 at 10 P. M.

October 18, 1899.—5 A. M., 102.9; 7 A. M., 102.8; 9 A. M., 104.3; 11 A. M., 105.6; 1 P. M., 104.9; 3 P. M., 104; 5 P. M., 103.5.

This cow occupied stall No. 6 in the dark stable. She remained in very good condition throughout the entire experiment. She was killed December 1, 1899. At that time the condition of nutrition was good. There was considerable subcutaneous fat and also a good deal of abdominal fat. In the right lung there were six small areas close to the surface containing yellow cheesy pus. The left lung contained more lesions of a similar character, the largest being about two and one-half inches in diameter. The left bronchial and mediastinal glands were enlarged and cheesy. On the posterior face of the diaphragm there was a hard fibrous growth three inches in diameter and two inches thick. In the centre of this was a cheesy area about one-half inch in diameter, just beneath the capsule.